University of Wisconsin Antarctic Soils Database, Version 1

USER GUIDE

How to Cite These Data

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National Snow and Ice Data Center

TABLE OF CONTENTS

1 DETAILED DATA DESCRIPTION

1.1 Chemical and physical properties of soils

The file "ggd221_ant_soillab.txt" contains chemical and physical properties for 214 soil samples in the McMurdo Sound area. Empty cells indicate missing data. Several site records are missing (for example, 75-2). Columns are described as follows:

Profile #: Pedon reference (site) number. Sites are numbered consecutively by year and in order of visit; for example, sites 75-1 through 75-38 indicate that researchers visited 38 sites in 1975.

Horizon: Soil horizon using standard nomenclature from Soil Survey Staff (1998) with some exceptions. For example, the symbol "D" indicates desert pavement, which is common in hot desert (Aridisols) and cold desert (Gelisols) soils. The Birkeland (1984) method is used to distinguish between unoxidized (Cn) and oxided (Cox) parent materials.

Sample #: Samples are numbered consecutively by site visit. For example, soil 75-1 contains five major horizons: D, Bw1, Bw2, BC, and Cn. Accordingly, these horizons are numbered 1 through 5.

Depth (cm): Depth of soil horizon

EC (dS/m): Electrical conductivity determined using a conductivity bridge/cell

pH: measured potentiometrically using a pH meter

Na^+, Ca^{2+}, Mg^{2+}, K^+, Cl^-, SO_4^{2-}, and **NO^{3-}**: In accordance with methods for sodic and saline soils (U.S. Salinity Laboratory 1954), 1:5 soil:distilled water extracts were prepared and samples were measured for pH, electrical conductivity (EC), major cations, and major anions. Cations were measured using flame photometry (Na, K) and atomic absorption spectroscopy (Ca, Mg) (APHA et al. 1976). From 1975 to the mid-1980's, SO_4 was measured by the turbidometric method, Cl by the potentiometric method (chloridometer), and NO_3 was estimated from cation:anion balances. After the mid 1980's, SO_4, Cl, and NO_3 were measured on a 2000i Dionex ion chromatograph.

Fed (%): Amount of free iron in selected samples, determined by extracting the soils with a citrate-dithionite-bicarbonate solution (Mehra and Jackson 1960)

% Sand, % Silt, and **% Clay**: Particle-size distribution, determined from dry sieving and the hydrometer method (Day 1965). The fractions include very coarse sand (2 mm to 1 mm), coarse sand (1 mm to 0.5 mm), medium sand (0.5 mm to 0.25 mm), fine sand (0.25 mm to 0.10 mm), very fine sand (0.10 mm to 0.05 mm), coarse silt (0.05 mm to 0.02 mm), medium and fine silt (0.02 mm to 0.002 mm), and clay (< 0.002 mm). Values are aggregated into percentage of sand, silt, and clay.

% moist: Gravimetric moisture content in selected samples.

1.2 Soil Descriptions Files

The files "ggd221_ant_mdv_soildes.txt" and "ggd221_ant_nonmdv_soils.txt" provide soil descriptions, locations, and soil-forming factors from 482 sites in the McMurdo dry valleys ("mdv") and outside the McMurdo dry valleys ("nonmdv"), respectively. Missing data are indicated by "nr" for "not recorded." Contents are summarized as follows:

Pedon Ref. No.: Pedon reference (site) number. Sites are numbered consecutively by year and in order of visit; for example, sites 75-1 through 75-38 indicate that researchers visited 38 sites in 1975.

Date: mm/dd/yy format

Location: General location within the McMurdo Dry Valleys -- by valley, glacier, and others. Most of the soils were located on a specific drift unit.

Landform: Most of the soil pits were located on moraine crests.

Parent material type/composition: Name of the drift unit and its overall composition.

Parent material age: Age of the drift unit.

Relief: Percent slope and position along the slope -- upper, middle, and lower.

Eco-climatic region: The McMurdo Sound area is divided into five ecoclimatic regions, including the coastal areas, the dry valley bottoms, the dry valley walls, the upland valleys and walls, and the polar plateau fringe (Campbell and Claridge 1998).

Patterned ground: Identified according to the terminology of Washburn (1956), including poorly sorted polygons, sorted polygons, and others.

Classification: Soils were classified into the Gelisol order to the family level (Soil Survey Staff 1998). All of the soils examined were mineral soils. Soils with one or more horizons that are cryoturbated are classified as Turbels. Soils without obvious cryoturbation are Orthels. Both suborders are divided into great groups on the basis of soil climate. Antarctic soils generally have anhydrous conditions -- the mean annual precipitation is less than 50-mm water equivalent; therefore, the soils are Anhyturbels or Anhyorthels. Antarctic soils are further subdivided into subgroups on the basis of presence or absence of soluble salts. For example, soils containing a petrogypsic, gypsic, nitric, salic, or calcic horizon are designated as Petrogypsic Anhyturbels/Anhyorthels, Gypic Anhyturbels/Anhyorthels, or others. Finally, the soils are classified into families on the basis of particle-size class, mineralogy class, and soil temperature class.

Horizon: Soil horizon using standard nomenclature from Soil Survey Staff (1998) with some exceptions. For example, the symbol "D" indicates desert pavement, which is common in hot desert (Aridisols) and cold desert (Gelisols) soils. The Birkeland (1984) method is used to distinguish between unoxidized (Cn) and oxided (Cox) parent materials.

Depth (cm): The depth of each horizon was determined from a control section representative of the four exposures in the soil pit.

Boundary: The topography and distinctness of the lower boundary was determined using criteria from the Soil Survey Staff (1998).

Munsell Color (dry): Munsell soil color was determined for field samples, which were dry unless reported otherwise.

Field texture: Field texture was estimated by hand texturing.

Structure: Most Antarctic soils are either massive or structureless, single grain.

Consistence Dry: Dry consistence was determined using criteria in the Soil Survey Manual (1993), as loose, soft, slightly hard, hard, or very hard.

Consistence Wet: The soil was wetted, and wet consistence was determined in terms of stickiness and plasticity, or, the degree of adherence of the soil between the thumb or and forefinger and the ability of the soil to be formed into a wire (Soil Survey Staff 1993).

Salt morph: A morphogenetic salt stage for soluble salts was developed by Bockheim (1990). According to this system, the form of soluble salts reflects soil age and is related to total dissolved salts from electrical conductivity measurements. Salt stage 0 contains no visible salts; salt stage 1 has coatings on the bottom of stones; salt stage 2 has salt flecks 1-2 mm diameter that cover < 20% of the surface area of the horizon; salt stage 3 has salt flecks 1-2 mm diameter that cover > 20% of the surface area of the horizon; salt stage 4 has a weakly cemented salt pan; salt stage 5 has a strongly cemented salt pan; and salt stage 6 has an indurated salt pan.

Cementation: cw = weakly cemeted, cs = strongly cemented, and ci = indurated.

Reaction to HCl: Some of the soils in the McMurdo Sound area contain secondary carbonates. These were detected by determining the degree of reactivity of the soils to 10% HCl: non-reactive, very slightly effervescent, slightly effervescent, strongly effervescent, and violently effervescent (Soil Survey Staff 1993).

Finally, the percentages of stones (> 30 cm), cobbles, (7.6-30 cm), gravel (0.2-7.6 cm), and coarse frags (< 2mm) were determined in the field by passing a volume of soil through a nest of sieves and weighing. These data are reported in the last four columns.

1.3 Antarctic Site Database

The file "ggd221_ant_sites.txt" includes data for ground-ice, soil profile, and surface boulder weathering features from 482 sites in the McMurdo Sound area. Empty cells indicate missing data.

Profile: Pedon reference (site) number. Sites are numbered consecutively by year and in order of visit; for example, sites 75-1 through 75-38 indicate that researchers visited 38 sites in 1975.

Ground ice and **Major ground ice**: Recorded using the following categories: active rock glaciers (rg); relict rock glaciers (rg); ice-wedge polygons (ip); sand-wedge polygons (sp); ice-cored drift (ic); fossil sand-wedge polygons (spf); and fossil ice-wedge polygons (ipf). Researchers identified active rock glaciers by their lobate forms and surface undulations on aerial photographs and on the ground. They generally had an ice core with 50 cm of the surface and featured upturned stones with mineral coatings. Inactive rock glaciers lacked an ice core within 100 cm of the surface but retained a general rock glacier outline observable on aerial photos and in the field. Fossil sand-wedge polygons lacked distinct high-centered polygons but retained cracks in the soil profile. Fossil ice-wedge polygons similarly lacked a distinct polygonal form but contained ice-wedge casts, or cracks filled in with mineral soil.

Staining depth (cm): Soil pits were excavated by hand at each site to a depth of at least 100 cm, unless bedrock, ice-cement, or large boulders prevented digging to that depth. The soil pits were approximately 150 cm long by 80 cm wide. The depth of staining refers to the thickness of the layer showing the strongest hues and chromas from oxidation of iron-bearing minerals. The depth of staining normally corresponds to either the bottom of the B horizon or on younger landforms an oxidized C horizon (Cox).

Coher. depth (cm): The depth of coherence refers to the thickness of consolidated soil. Consolidation is caused by the accumulation of weathering products such as salts, iron oxides, clays, etc. Below the depth of coherence, the soil readily caves into the pit due to the presence of loose and non-coherent materials.

Vis. salts depth (cm): The depth of visible salts refers to the maximum depth for which salt encrustations beneath clasts, salt flecks, and other salts forms are readily visible to the naked eye.

Max. Ghosts: The depth of ghosts refers to the maximum depth for which weathered clasts (also called pseudomorphs) were observed. This depth varies by rock type. The maximum depth of ghosts is reported, regardless of rock type.

Ice cement: Depth to an ice-cemented layer. Much of the permafrost in the McMurdo Dry Valleys is "dry"; there is insufficient interstitial moisture for the material to be cemented. Cementation by ice can occur with as little as 10% moisture content on a weight basis.

CDE: Maximum color development equivalence (CDE) is the product of hue (coded) and value from Munsell soil color charts (Buntley and Westin, 1963). The hue codes are: 10R = 7, 2.5YR = 6, 5YR = 5, 7.5YR = 4, 10YR = 3, 2.5Y = 2, and 5Y = 1. For example, a soil with a color of 7.5YR 4/3 would have a CDE of 4 x 3 = 12.

Salt stage: Bockheim (1990) developed a morphogenetic salt stage for soluble salts. According to this system, the form of soluble salts reflects soil age and is related to total dissolved salts from electrical conductivity measurements. Salt stage 0 contains no visible salts; salt stage 1 has coatings on the bottom of stones; salt stage 2 has salt flecks 1-2 mm in diameter that cover < 20% of the surface area of the horizon; salt stage 3 has salt flecks 1-2 mm in diameter that cover > 20% of the surface area of the horizon; salt stage 4 has a weakly cemented salt pan; salt stage 5 has a strongly cemented salt pan; and salt stage 6 has an indurated salt pan.

Salt pan (cm): Salt stages 4 through 6 reflect salt pans of differing degrees of cementation. This data column reports the thickness of the salt pan, regardless of its degree of cementation. Salt pans are designated in the files "ggd221_ant_mdv_soildes.txt" and "ggd221_ant_nonmdv_soils.txt" with the symbols "ym" or "zm," depending on whether the cementing agent is gypsum or a salt more soluble than gypsum.

Weath stage: The weathering stage is intended to be an overall representation of the age of the landscape/material based on the degree of surface boulder weathering and soil morphology (Campbell and Claridge 1975). Weathering stage 1 has fresh, unstained and angular boulders, 5Y soil colors, minimal horizon development, stage 0 salts, very shallow ice-cemented permafrost, and moderate patterned ground development. Weathering stage 2 has light staining of boulders with some disintegration, 10YR 6/3-2.5Y 6/2 soil colors, weak horizon development, stage 2 salts, shallow ice-cemented permafrost, weak soil horizon development, and strong patterned ground development. Weathering stage 3 has boulders distinct polish, staining, and rounding, some cavernous weathering and ventifacts, 10YR 5/3-2.5Y 6/4 soil colors, distinct horizon development, stage 3 salts, moderately deep soil depth, and some ghosts. Weathering stage 4 has boulders much reduced by rounding, crumbling and ventifaction, strongly developed cavernous weathering, well developed staining and polish, and some desert varnish; 10YR 5/4 soil colors; very distinct soil horizons; salt stage 4; deep soil profiles; and some ghosts. Weathering stage 5 has few boulders, a well developed desert pavement with extensive crumbling, rounding, pitting and polish; 10YR 4/4-5YR 5/8 soil colors; very distinct soil horizon development; stage 5 salts; deep soil profiles; and some ghosts. Weathering stage 6 has weathered and crumbled bedrock; very strongly stained residual materials; 7.5YR 5/6-5YR 4/8 or 2.5YR 3/6 soil colors; very distinct soil horizon development; stage 6 salts; shallow to deep profiles; and bedrock sometimes crumbled to 50 cm in depth.

SBF #/314: At each site either a circular plot with a 10-m radius or a line transect was laid out for determining surface boulder frequency (SBF). SBF is reported as the number of boulders per 314 m^2 plot.

D:S: At each site either a circular plot with a 10-m radius or a line transect was laid out for determining the dolerite-to-sandstone ratio. The ratio of dolerite (diorite) to sandstone boulders applies only to areas with the Beacon Supergroup Formation.

Stria., Varn., Spall., Pitting, and **Vent.**: Proportion (%) of the boulders on the plots featuring striations, desert varnish, spalling (exfoliation), pitting, and ventification, respectively.

For relative dating purposes, researchers reported the maximum electrical conductivity in the profile recorded in dS/m (**Max. EC (dS/m)**), the total amount of salts to a depth of 70 cm (**Salts to 70 cm**), the mmol% of anions in 1:5 soil:water extracts (**Cl, SO_4**, and **mmol% NO^3**), the maximum % dithionite-extractable Fe (**%Fed**), and the maximum concentrations of silt and clay (**%Si** and **%C**) in the profile. Soils influenced by marine aerosols from McMurdo Sound are enriched in Cl, and soils along the polar plateau are dominated by NO_3; soils intermediate from the coast and the plateau contain primarily SO_4.

Researchers calculated profile quantities of salts to a depth of 70 cm (column 22 in "ggd221_ant_sites.txt") from the following equation (Bockheim 1979):

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EC (dS/m) x thickness (cm) x 4.8
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1.4 Format

Data are in tab-delimited ASCII text format.

1.5 File Naming Convention

The file "`ggd221_ant_sites.txt`" contains general site information, one-time air and soil temperature measurements, general soil profile features, and surface boulder weathering features for 482 sites in the McMurdo Sound area.

The file "ggd221_ant_nonmdv_soils.txt" contains profile descriptions of soils outside the McMurdo Dry Valleys.

The file "ggd221_ant_mdv_soildes.txt" contains profile descriptions of soils in the McMurdo Dry Valleys.

The file "ggd221_ant_soillab.txt" contains chemical and physical properties for 214 of the soils.

1.6 File Size

ggd221_ant_sites.txt: 32 KB

ggd221_ant_nonmdv_soils.txt: 196 KB

ggd221_ant_mdv_soildes.txt: 496 KB

ggd221_ant_soillab.txt: 72 KB

1.7 Spatial Coverage

The study area spans from 77° 07.5' S to 78° S, and from 160° E to 164° E.

1.8 Temporal Coverage

Dry valleys: 23 December 1975 to 22 December 1987
Outside dry valleys: 13 November 1978 to 04 January 1986.

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4 DOCUMENT INFORMATION

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